MASTER DRAINAGE STUDY AND PLAN
EXECUTIVE SUMMARY

Prepared for:

ARIZONA
CITY OF MARICOPA

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The MDP was developed in two phases. The goal of Phase I was to:

- Remove the downtown area of the City from the Federal Emergency Management Agency (FEMA) designated floodplain zone "AO" through a Conditional Letter of Map Revision (CLOMR) submittal to FEMA. A zone AO floodplain is an area expected to flood during the 100-year (1% annual chance) event with flood depths of 1 to 3 feet. The average depths are determined and shown on the FEMA maps; and

- Provide aerial and topographic mapping for the entire City study area at two foot contour intervals.

The purpose of Phase II was to:

- Provide a method for the City to regulate development and to protect future residents from flooding; and

- Provide a consolidated assessment of existing drainage conditions within the City.

The MDP effort included survey and mapping, hydrology and hydraulic evaluation, public meetings and stakeholder workshops, City Planning overview, and the development of elements to minimize the risk of flood related damage. The flooding sources for the City were identified and characterized, and existing conditions were evaluated for potential drainage and flooding issues.

A comprehensive inventory of all man-made drainage structures, such as culverts, bridges, storm drains, siphons, embankments, and channels was obtained from previous MDPs, development plans and field reconnaissance. The inventory is available in the Data Collection Report, which has been included electronically in **Appendix H** of the Master Drainage Study and Plan report.

The three major off-site flooding sources that pass through the City are the Santa Cruz Wash, the Santa Rosa Wash, and the Vekol Wash (and tributaries). These sources are mapped as floodplains by FEMA and are shown on the Flood Insurance Rate Maps (FIRMs) for the study area. Additionally, two unnamed flooding sources drain into the Santa Cruz Wash from the east. For the purposes of this report, they are referred to as South Side Canal Flows and Local Sacaton Flows.

Each region on **Figure 2** represents an area that is subject to flooding from the associated flooding source. The limits between each region are approximate. Detailed off-site flow analysis for proposed improvements should occur using the appropriate flooding source.

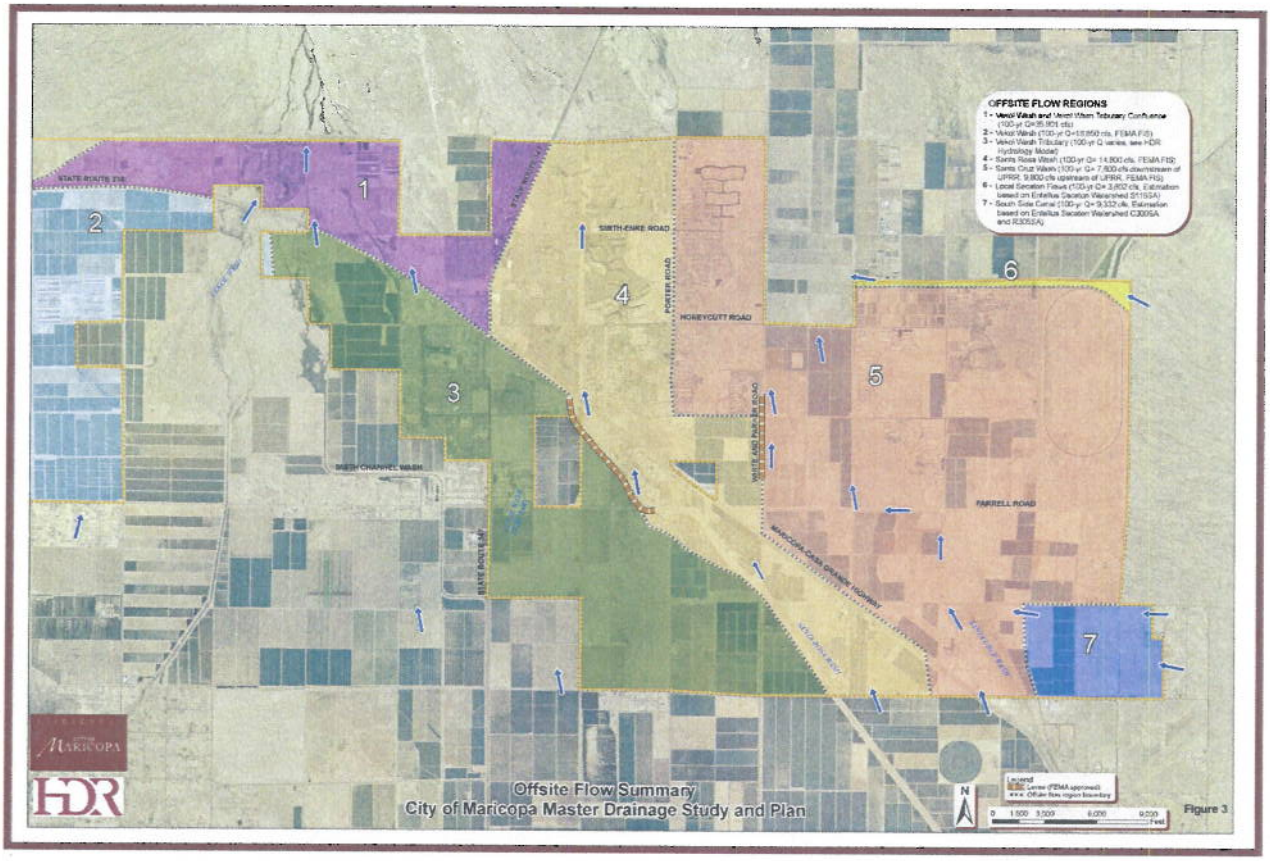


Figure 2 – Offsite Flow Summary

Numerous berms and non-levee embankment structures exist within the City. These occur at irrigation canals, drainage channels, agricultural fields, roadways, and railroad tracks. It is generally difficult to accurately characterize the effects that non-engineered structures have on regional drainage as they may fail during flooding events, sometimes after upstream water has collected behind them. This phenomenon can cause flooding that exceeds the pre-structure condition. Therefore, FEMA recently changed mapping standards to include the worst-case scenario of both the non-levee embankment failing and the non-levee embankment remaining intact when preparing FIRMs.

However, there are two structures within the City limits that are considered levees and provide flooding protection. These are FEMA-accredited levees, and are located at:

- the Santa Rosa Wash between Farrell Road and Maricopa-Casa Grande Highway; and
- adjacent to White and Parker Road from north of Farrell Road to just north of Bowlin Road.

The levees are shown graphically in **Figure 2**, above, and information on these structures are contained in **Appendix C** of the Master Drainage Study and Plan report.

HYDROLOGY AND HYDRAULICS

Existing studies and/or reports were utilized for the quantities of flow arriving at and through the City, with exceptions as discussed below. **Table 1** summarizes the off-site flow amounts entering the City.

Table 1: City of Maricopa Flooding Sources

FLOODING SOURCE (Region per Figure 3)	FLOW (Cubic feet per second)	REFERENCE
Vekol Wash (Region 2)	18,850	FEMA FIS, 2007
Vekol Wash Tributary (Region 3)	Varies, see App. C	HDR Hydrology Technical Memorandum, 2009
Santa Rosa Wash (Region 4)	14,800	FEMA FIS, 2007
Santa Cruz Wash (Region 5)	9,800	FEMA FIS, 2007
Local Sacaton Flows (Region 6)	3,802	Estimated based on USGS Regression equations on Sacaton Mtn ADMP Watershed S115SA
South Side Canal (Region 7)	9,332	Estimated based on USGS Regression equations on Sacaton Mtn ADMP Watershed C300SA and R305SA

Vekol Wash

The Vekol Wash is a FEMA mapped Zone AO flood hazard within the City limits. FEMA Flood Insurance Rate Map (FIRM) number 04021C0730E, effective December 4, 2007 delineates the floodplain boundary.

Vekol Wash Tributary

A detailed hydrologic model was created for the Vekol Wash Tributary as part of the MDP. The Vekol Wash Tributary watershed is approximately 196 square miles and bounded by the Union Pacific Railroad (UPRR) Tracks to the north, the Vekol Wash watershed to the west, the Table Top Wilderness Mountains to the south, and the Santa Rosa Wash watershed to the east. The Vekol Wash Tributary joins the Vekol Wash approximately 4 miles to the north of the boundary of this study.

Two previous sources of flow information exist for the Vekol Wash Tributary. The flows published by FEMA in the 2007 Flood Insurance Study (FIS) indicate that 13,700 cfs

arrive at the UPRR tracks. However, a LOMR was filed in 2007 that indicates that only 1,628 cfs arrive at the same location.

It was determined that neither of the two previously published flows could be used on this task for the following reasons:

- The FIS flow of 13,700 cfs was taken from regression equations and does not account for the unique conditions of the watershed due to development, flow splits, and agricultural uses.

- The Santa Rosa LOMR flow of 1,628 cfs was based on very specific conditions in the upstream watershed, including the presence of specific agricultural crops and grading conditions. It is unlikely that these conditions will exist at all times, even within a single growing season, due to crop rotations and other reasons discussed in the Hydrology Technical Memorandum, which is included in **Appendix C** of the Master Drainage Study and Plan report.

A new HEC-1 model was created for this study to more accurately define the existing conditions of the Vekol Wash Tributary for the 100-year, 24-hour storm. The model consists of NOAA Atlas 14 precipitation estimates, Green and Ampt equation to estimate rainfall losses, and S-graph generated hydrographs. **Table 2** summarizes new flows from this analysis for several points of interest within the City.

Table 2: New Vekol Wash Tributary Flows

HEC-1 CONCENTRATION POINT	FLOW (cubic feet per second)	DESCRIPTION
CP99	8,566	At UPRR south of Royal Dunes Golf Club
CP97	8,385	At UPRR near Green Road alignment
CP98	7,637	At UPRR and State Route 347
CP96a	8,900	Near Bowlin Road and State Route 347
CP96	9,504	Near Farrell Road and State Route 347
CP92	11,791	Near Steen Road and State Route 347

Santa Rosa Wash

The Santa Rosa Wash is a FEMA mapped Zone AO within the City limits. The Santa Rosa LOMR, effective December 27, 2007, revised the FEMA FIRM number 04021C0745E. This revision changed the area adjacent to the west side of the Santa Rosa Wash, from Maricopa-Casa Grande Highway south to just south of Farrell Road, from a mapped Zone AO to Zone X due to the certification of an engineered levee along

that stretch of the wash. The LOMR did not revise the Santa Rosa floodplain on FEMA FIRM 04021C0775E or 04021C1150E.

Santa Cruz Wash

The Santa Cruz Wash is a FEMA mapped Zone "A" flood hazard within the City limits. A Zone A flood hazard is one that has been determined by approximate methods. A LOMR effective November 6, 2008 revised the floodplain limits of the Santa Cruz Wash on FEMA FIRM 04021C0775E due to a levee system along the west side of White and Parker Road located just north of Farrell Road to just north of Bowlin Road. FEMA FIRM panel 04021C1150E was not revised by the LOMR.

Local Sacaton and South Side Canal Flows

Floodplain mapping for the Local Sacaton flows and the South Side Canal flows entering the City at the east boundary does not exist. It is recommended that future floodplain mapping be performed for these two flooding sources. An effective hydraulic model for the existing Vekol Wash Tributary area was not available.

Through the data collection efforts and hydrologic and hydraulic analysis of the City's flooding sources, several existing drainage problem locations were identified. **Appendix E** of the report contains enlarged images of each of the 17 identified drainage problem areas with detail descriptions for clarification. **Table 3** and **Figure 3** provide a brief summary and identify the location for each below.

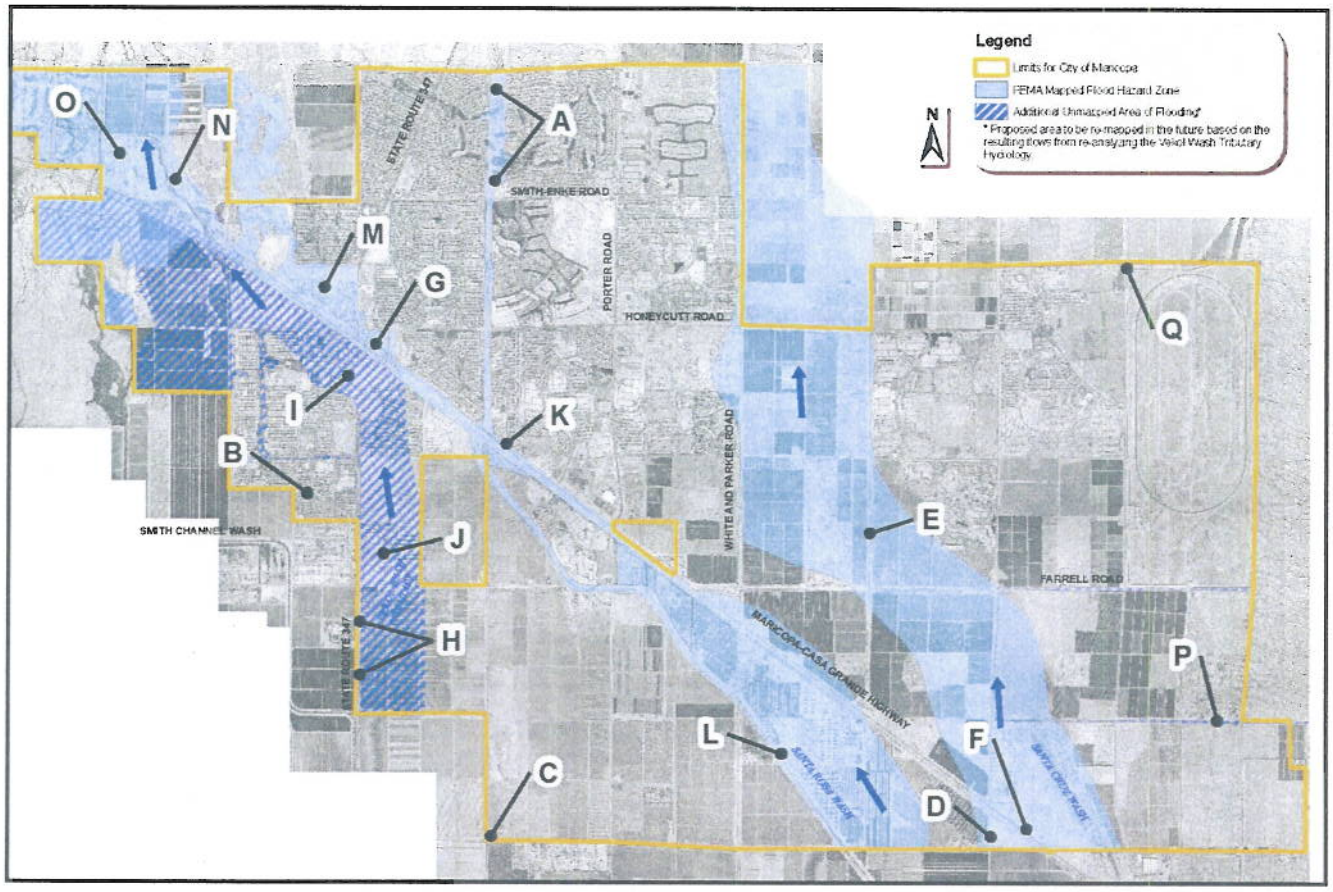


Figure 3 – Drainage Issues

Table 3: Summary of Drainage Issues

Area ID	Location	Description
A	Rancho El Dorado Pkwy (2 locations)	At-grade crossings flood during runoff events.
B	S. of Norris and Alterra Parkway	Scupper discharges into street.
C	Smith Wash at Peters and Nall Road	Box crossing undersized, flow breaks out to the north.
D	Santa Cruz Wash upstream of M-CG Highway	Flows break out of main channel and travel to the northwest to combine with Santa Rosa flows.
E	Santa Cruz Wash Regional Solution	Wide floodplain, at-grade crossings flood during runoff events.
F	Santa Cruz Wash at M-CG Highway	Wash floods road and causes road closure.
G	M-CG Highway near Maricopa Groves Pkwy	Ditch lacks outlet.
H	SR 347 south of Farrell Road	Flow overtops SR 347 from east.
I	SR 347 south of M-CG Highway	Flow overtops SR 347 from east.
J	Palo Brea subdivision	Flooding expected but entire subdivision not mapped in floodplain.
K	Rosa Parkway near M-CG Highway	Undersized culvert under Rosa Parkway.
L	Santa Rosa Wash south of Farrell Road	Floodplain outside of channel; levees not approved by FEMA.
M	Downtown CLOMR Channel	Entire downtown area in floodplain.
N	Vekol Wash Tributary - Northern Section	Undersized bridge at UPRR, at-grade crossing at SR 238, wide floodplain.
O	Vekol Wash	Undersized crossings at UPRR/SR 238, wide floodplain.
P	South Side Canal Flows	Undersized channel and culvert crossings.
Q	Sacaton Flows	Undersized channel and culvert crossings.

Potential flooding from the Vekol Wash Tributary, which encompasses Items H, I, J, M, and N in the table above, is of particular concern. The flooding is expected to inundate numerous structures including residences, businesses, and a school, and could overtop the SR 347 roadway in several locations. Since the area is not mapped as a floodplain by FEMA, the residents may be unaware of the danger and likely are not carrying flood insurance.

Additionally, the overtopping of SR 347 is a public safety hazard for drivers and eliminates an emergency access route for the City. FEMA has initiated a re-study effort for this flooding source, which should be completed and published within several years. This study will revise the published floodplain maps and will not impact any of the proposed solutions recommended with this study (discussed below).

PROPOSED SOLUTIONS

Proposed solutions to the 17 drainage issues areas as discussed above were developed conceptually. In general, the improvements seek to pass flows through the City with as little adverse impact as possible. The improvements are summarized below in **Table 4** and shown graphically on **Figure 4.** Although shown in a specific location on the figure, the alignment and exact location of each improvement may change based on future detailed planning and development efforts.

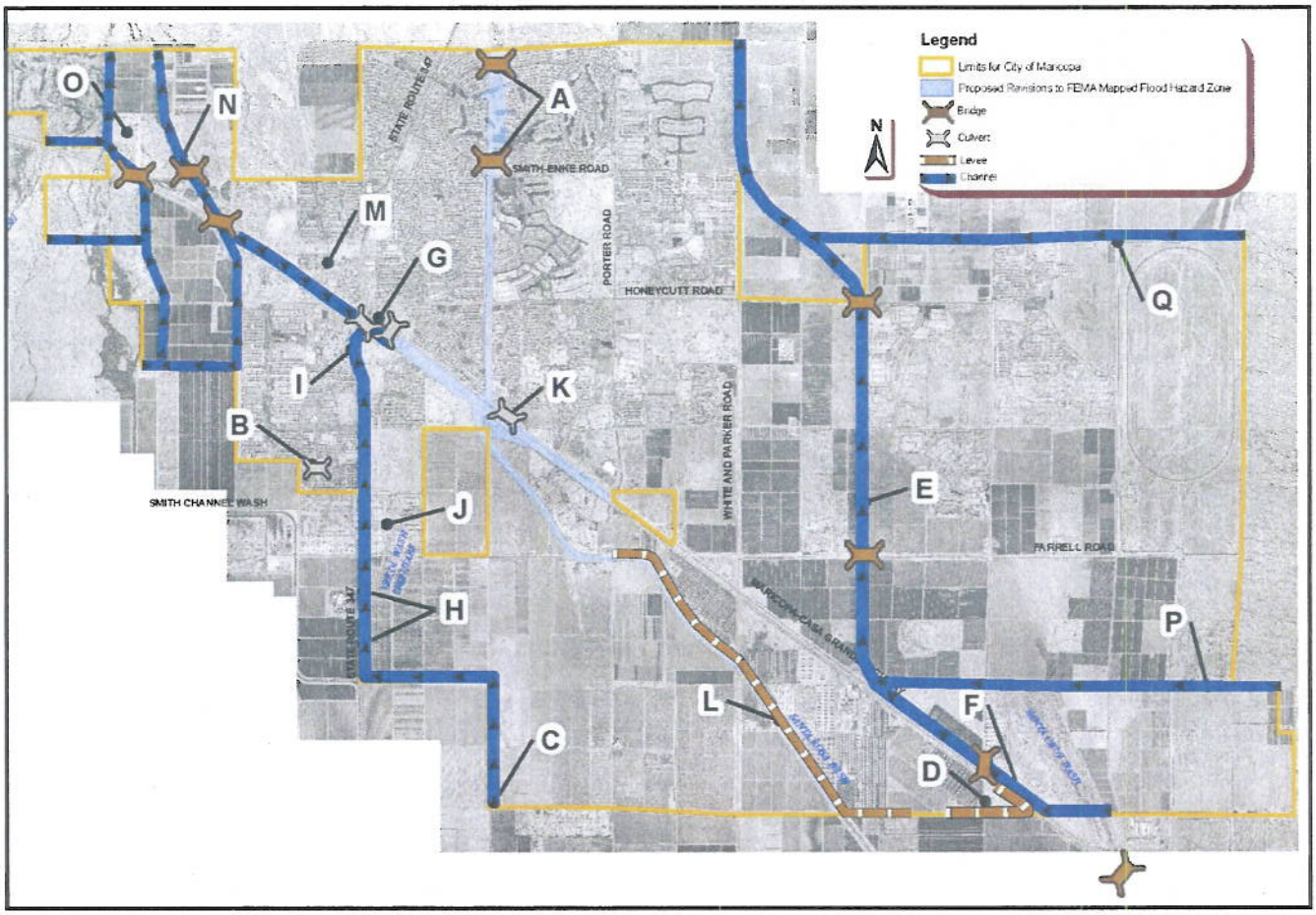


Figure 4 – Drainage Solutions

Table 4: Summary of Drainage Solutions

Area ID	Location	Solution	Notes
A	Rancho El Dorado Pkwy (2 locations)	Bridge (2)	Access available via Smith Enke to the south (already bridged)
B	South of Norris and Alterra Parkway	Inlet and storm drain piping	
C	Smith Wash at Peters and Nall Road	Channel	Since culvert drains onto Ak-Chin land, implications to upsizing culvert.
D	Santa Cruz Wash upstream of M-CG Highway	Grading improvements/bridge crossing	Channelizing flow to north probably best Depending on where flow leaves main channel, might not be much that can be done upstream since outside City limits
E	Santa Cruz Wash Regional Solution	Channel system and bridges (3)	Bridges at location of regional solution channel.
F	Santa Cruz Wash at M-CG Highway	Bridge	One of main routes in/out of the City, on emergency evacuation plan; Bridge likely located outside City limits
G	M-CG Highway near Maricopa Groves Pkwy	Culvert	Improvement proposed on Downtown CLOMR
H	SR 347 south of Farrell Road	Channel and retention	
I	SR 347 south of M-CG Highway	Channel and retention	Interceptor channel to tie into Downtown CLOMR channel
J	Palo Brea subdivision	Map floodplain, channel	
K	Rosa Parkway near M-CG Highway	Culvert	
L	Santa Rosa Wash south of Farrell Road	Levee or channel improvements	Channel improvements might not be possible due to grade restrictions, may require levee
M	Downtown CLOMR Channel	Channel and culvert (1)	Conceptual level design completed
N	Vekol Wash Tributary - Northern Section	Channel system and bridges (2)	Larger size channel and bridges due to expected flows
O	Vekol Wash	Channel system and bridge	Larger size channel and bridges due to expected flows
P	South Side Canal Flows	Channel and culverts or bridges (3)	Larger size channel and culverts/bridges due to expected flows
Q	Sacaton Flows	Channel and culverts or bridges (3)	Improvements to berms at proving grounds may be necessary

The 17 projects identified by the study team to solve flooding issues within the City of Maricopa were evaluated by a Technical Advisory Committee consisting of members from the City and stakeholders including Pinal County, Ak-Chin Indian Community, Gila River Indian Community, and Maricopa Flood District. Due to limited resources, not all of the 17 projects can be constructed immediately or at the same time. The results of the criteria evaluation as collaboratively determined by the group are summarized in **Figure 5** below.

ID	Location	DESCRIPTION	EVALUATION CRITERIA							
			Public Safety	Benefit	Environmental Impact	Cost	Maintenance	Plans, Goals, Objectives	Social Justice	
A	Rancho El Dorado	At Grade crossing floods	○	◒	●	◒	◒	●	●	
B	Norris and Alterra Pkwy	Scupper into street	●	●	●	●	●	●	●	
C	Smith Wash at Peters and Nall	Box crossing undersized	◒	●	◒	◒	●	◒	◒	
D	Santa Cruz Wash upstream of M-CG Hwy	Flow break out to NW into SR	●	◒	◒	●	◒	○	◒	
E	Santa Cruz Wash Regional Solution	Wide floodplain, flooded roads	◒	●	●	●	●	●	◒	
F	Santa Cruz Wash over M-CG Hwy	At grade crossing, closes road	●	●	●	◒	◒	●	●	
G	M-CG Hwy near Maricopa Groves Pkwy	Ditch lacks outlet	●	◒	●	●	●	○	●	
H	SR347 south of Farrell Road	Flows overtop SR347	●	●	◒	◒	◒	●	◒	
I	SR347 south of M-CG Hwy	Flows overtop SR 347	●	●	◒	◒	◒	●	●	
J	Palo Brea subdivision	Flooding in subdivision	◒	●	◒	◒	◒	●	●	
K	Rosa Pkwy	Undersized culvert	◒	◒	●	●	●	◒	●	
L	Santa Rosa Wash south of Farrell	Undersized/non certified channel	◒	●	◒	◒	◒	◒	◒	
M	Downtown CLOMR channel	Downtown in floodplain	●	●	◒	◒	◒	●	●	
N	Vekol Wash Tributary northern section	Undersized crossings, floodplain	●	●	●	●	●	◒	◒	
O	Vekol Wash	Undersized crossings, floodplain	●	●	●	●	●	◒	◒	
P	South Side canal flows	Undersized channel	◒	◒	◒	●	●	○	◒	
Q	Sacaton flows	Undersized channel	◒	◒	◒	◒	◒	◒	◒	

Figure 5 – Criteria Evaluation Results

Figure 5 (con't) – Criteria Evaluation Results Index to Symbols

Most of the projects are stand-alone efforts and can be implemented without coordination with any other plan. However, some of the proposed solutions require coordination amongst each other.

Floodplain delineation and potential improvements to the South Side Canal (P) and Local Sacaton (Q) flows are additional independent projects. It would be best to coordinate these two projects with the Santa Cruz Wash Regional Solution (E), as the channelizing improvements for each of these projects will convey these flows to the Santa Cruz. Currently, these flows arrive at the Santa Cruz Wash by way of roadside ditches and overland flow. Coordination of the outlets of these two proposed channels with the Santa Cruz Regional Solution is recommended.

As part of the MDP, additional efforts were performed on the downtown area of the City. The principal flooding source for the downtown area is the Vekol Wash Tributary. As a result of the analysis, the FEMA mapped flood zones were determined to require revision. The FEMA mapped flood zones south of the UPRR shown in **Figure 6** should be remapped to express the actual flooding limits estimated through this study, approximated in **Figure 7**.

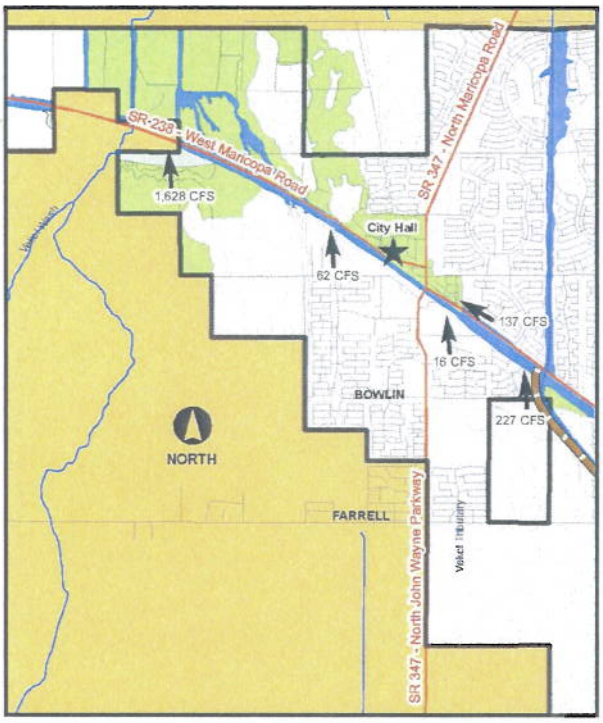


Figure 6 – Effective Floodplain Map

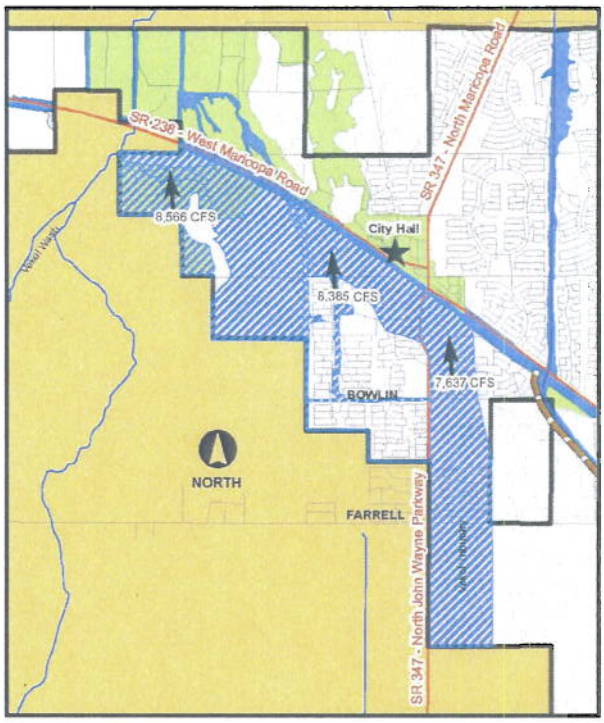
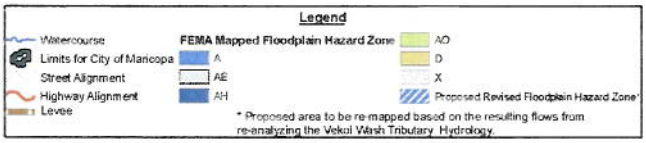


Figure 7 – Approximate Proposed Floodplain Revisions



The proposed floodplain limits shown on **Figure 7** are estimated limits for discussion purpose only. A detailed hydraulic analysis has not yet been conducted for FEMA floodplain remapping. The City of Maricopa was rewarded their request to FEMA for floodplain remapping, and this area is planned for FEMA floodplain remapping in the near future.

To remove downtown Maricopa from the floodplain, the Downtown CLOMR channel (M) is proposed upstream of the UPRR. To relieve shallow flooding and remove the City's downtown area from the floodplain of Vekol Wash Tributary and contributing local flows, four conceptual design alternatives were developed. The chosen alternative consisted of a proposed channel installation adjacent to the south side of the UPRR alignment, beginning just east of State Route 347 and ending just west of the Green Road alignment. Conceptual design plans were

developed for this channel, and are included in **Appendix G** of the Master Drainage Study and Plan report.

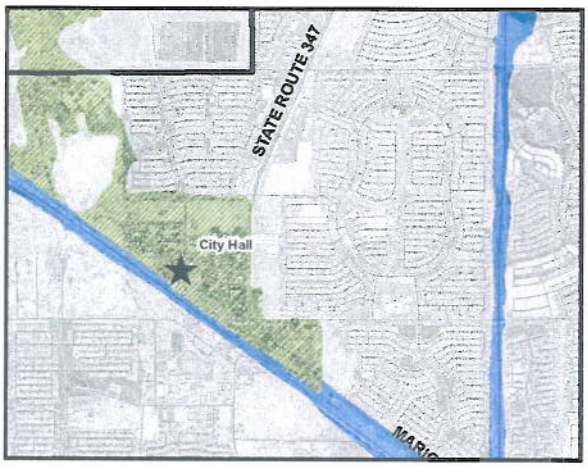


Figure 8 – Effective Floodplain Limits Downtown

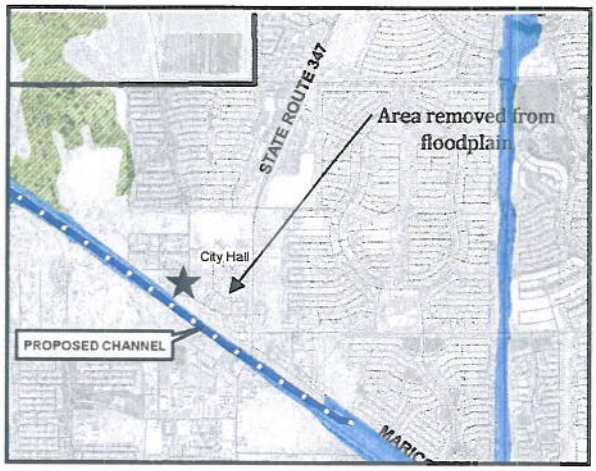
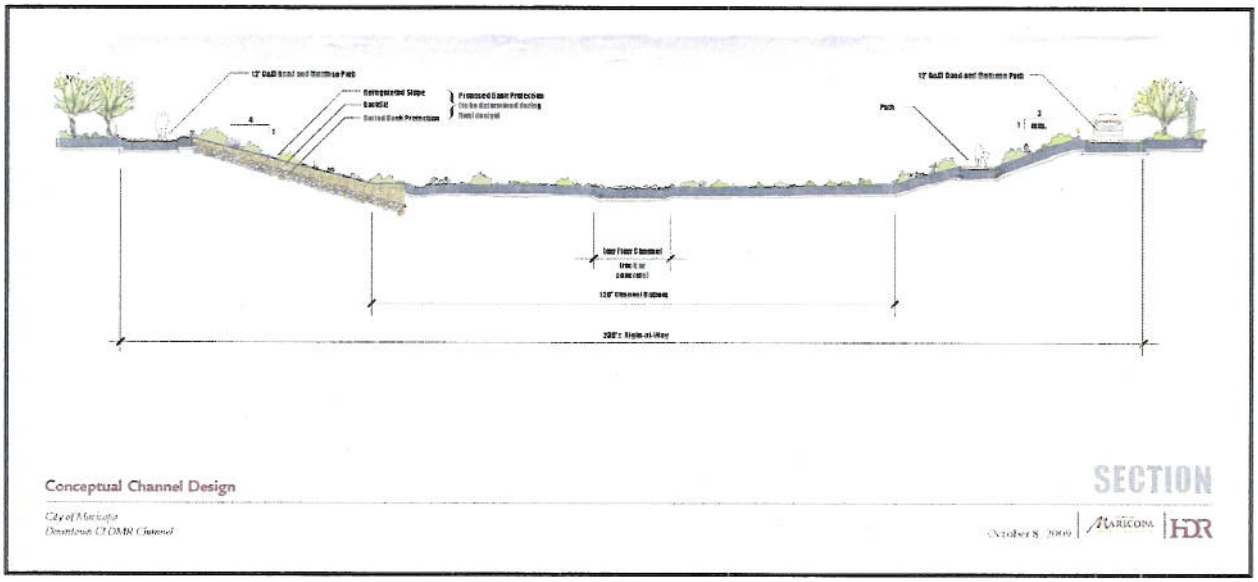
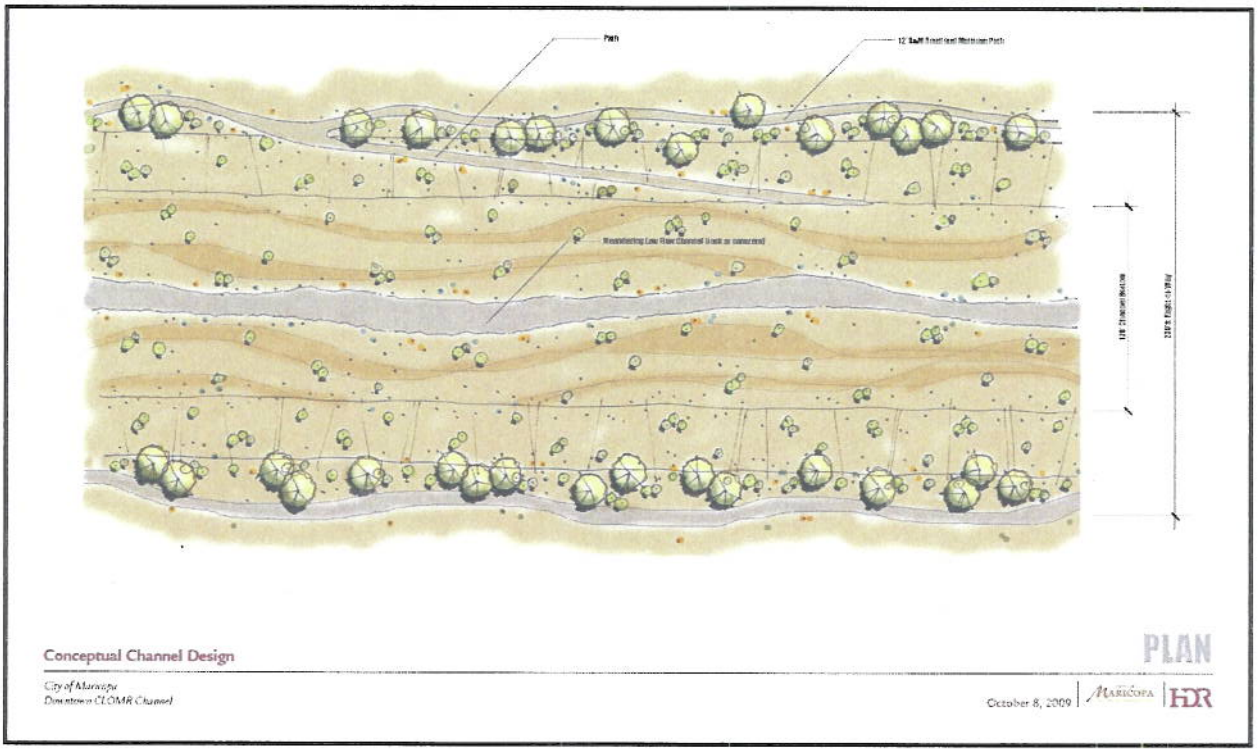


Figure 9 – Proposed Downtown Floodplain Revisions

As a result of the Downtown CLOMR channel analysis, HDR proposes that the current FEMA mapped flood zones north of the UPRR shown in **Figure 8** be remapped to remove the downtown from the floodplain as shown in **Figure 9** when the channel is in place.

The proposed channel provides the City with opportunity to allow connection of a multiuse system that will have paths that can meander along the full length of the channel alignments, as shown below in the conceptual channel section and plan exhibits.





RECOMMENDATIONS

The flooding sources for the City were identified and characterized, and existing conditions were evaluated for potential drainage and flooding issues. This Master Drainage Study and Plan document recommends the following items:

- Determination of the actual flooding limits of the Vekol Wash Tributary flooding source, as many homes, business and residents may be affected. This includes working with FEMA to conduct a detailed hydraulic analysis and floodplain remapping of the flooding source.
- Determination of the flooding hazards and inundation limits associated with the Local Sacaton and South Side Canal flows. Some residences may be affected.
- Determination of the effects of the Proving Grounds berms, channels, and grading on downstream flow characteristics.
- Implementation of the solutions to the 17 identified drainage issues (summarized in **Table 4**).
- Appropriate evaluation of the environmental impacts for the 17 proposed drainage solutions.
- Investigation of the off-site flooding potential based on the off-site flow regions of **Figure 3** for future development projects.
- Coordinate with the Pinal County Flood Control District's future plans for a gage network to monitor floods within the county.
- Collaborate with the region's various stakeholders as plans for the recommended projects develop to be sure the solutions consider both local and regional solutions.

Potential flooding from the Vekol Wash Tributary, discussed in the first bullet above, is of particular concern. The flooding is expected to inundate numerous structures including residences, businesses, and a school, and could overtop the SR 347 roadway in several locations. The overtopping of SR 347 is a public safety hazard for drivers and eliminates an emergency access route for the City. FEMA has initiated a re-study effort for this flooding source, which should be completed and published within several years. This study will revise the published floodplain maps and will not impact any of the proposed solutions recommended with this study.